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NASA RESEARCH AND EDUCATION NETWORK



**NASA/NREN**

**Next Generation Internet (NGI) Activities**

Richard desJardins

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*Tomorrow's Networking Applications Today*

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**Agenda**

- **NREN/NGI Architecture**
- **NREN Applications**
- **NREN Applied Research**

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# NGI Architecture



## NASA Research and Education Network (NREN)

NASA Funded  
ATM Backbone

## Very High-Speed Backbone Network (vBNS)

NSF Funded  
ATM Backbone

## Earth Sciences Network (ESnet)

Department of Energy Research & Operational Network  
ATM Backbone

## Defense Research and Education Network (DREN)

ATM Backbone

## SuperNet (Terabit Research Network)

DARPA Funded  
Basic Research (ATM, SONET & WDM)

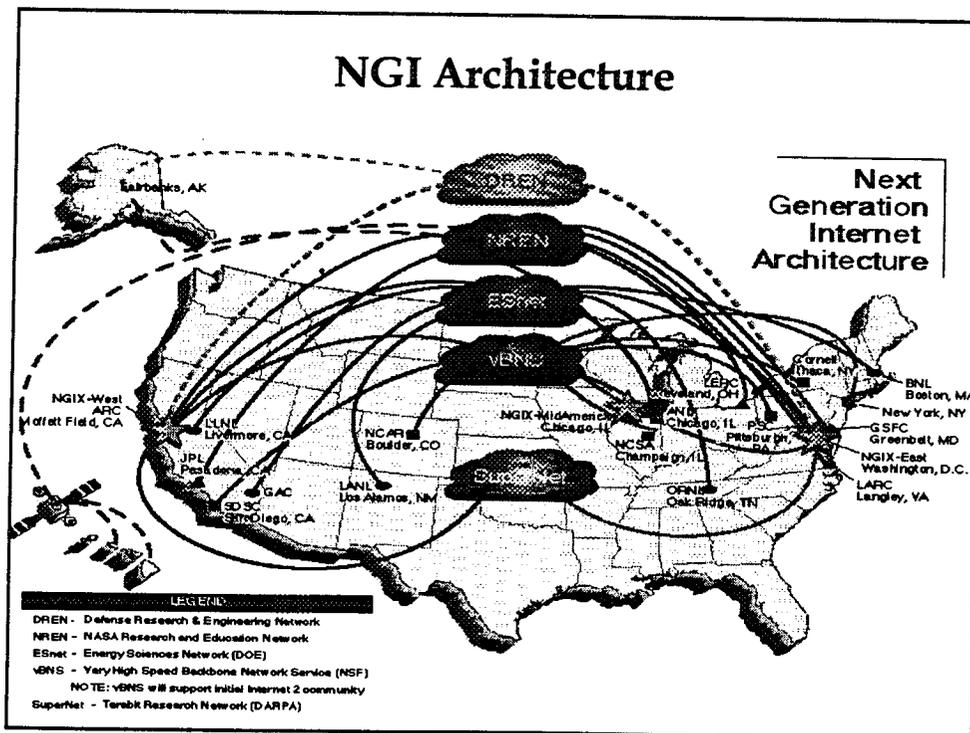
## Abilene

Internet 2 Backbone  
Packet over SONET



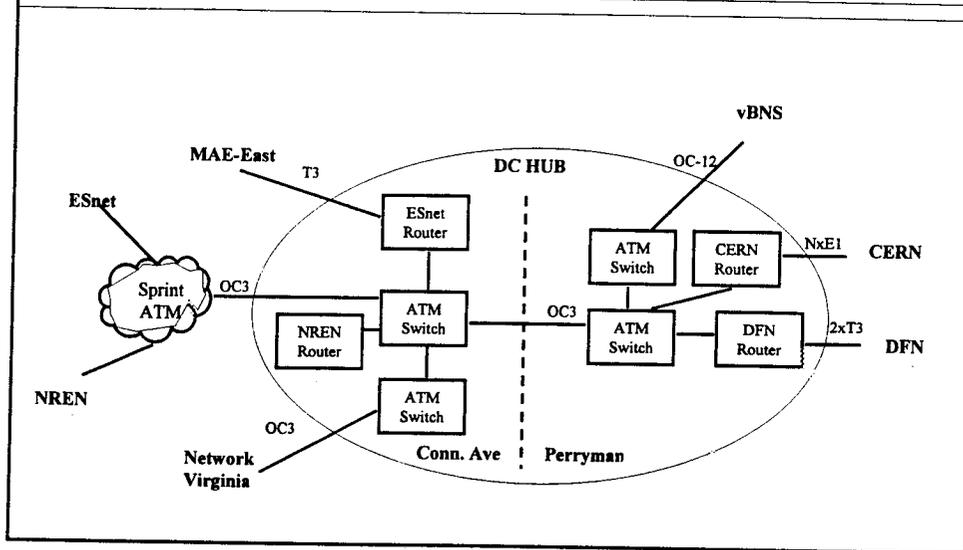
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# NGI Architecture



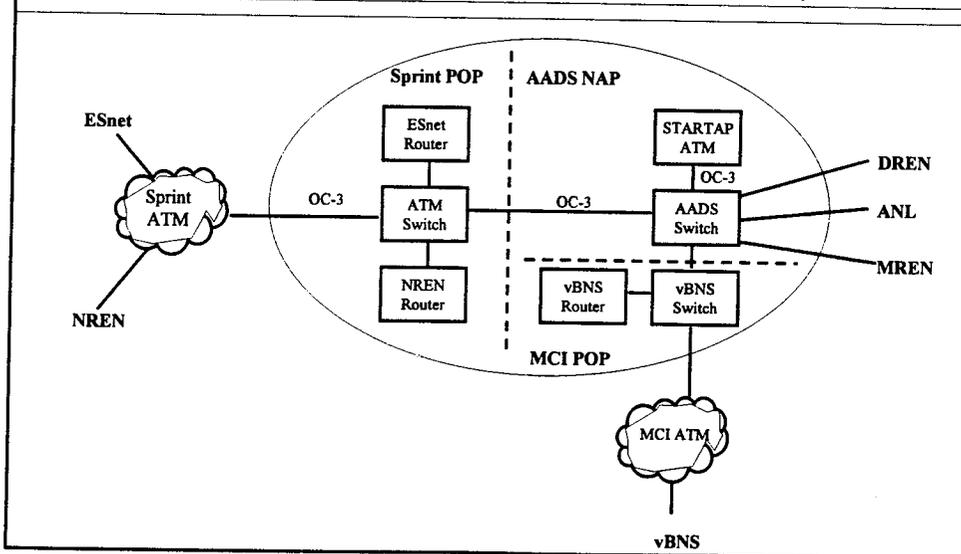
# NGI Architecture

## DC-NGI Exchange Point (NGIX-East)



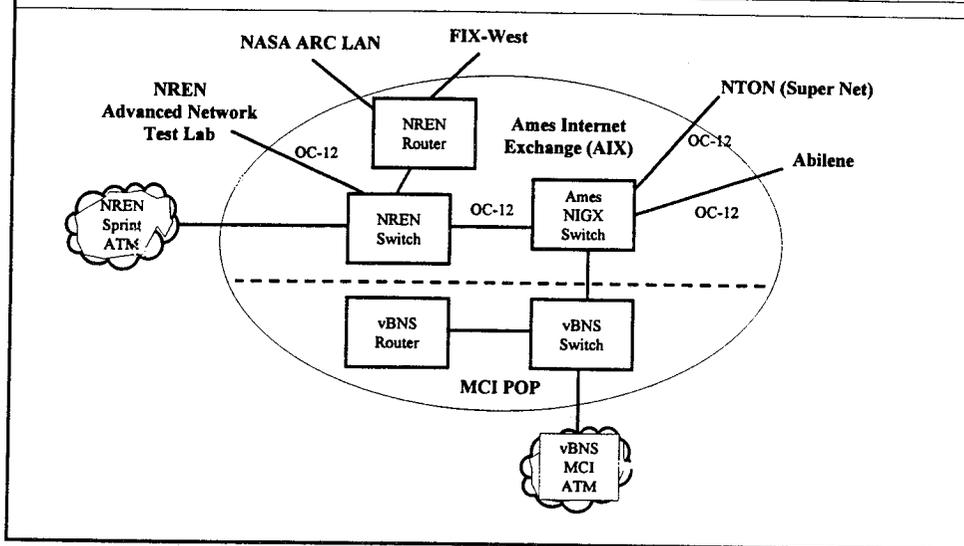
# NGI Architecture

## Chicago-NGI Exchange Point (NGIX-Mid)



## NGI Architecture

### Ames-NGI Exchange Point (NGIX-West)



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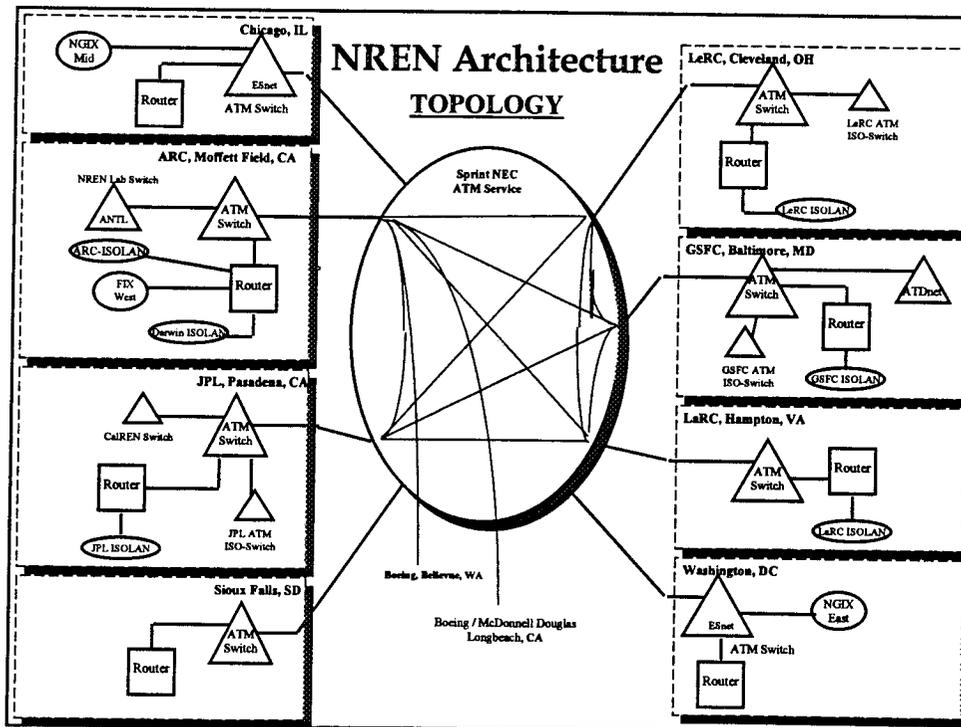
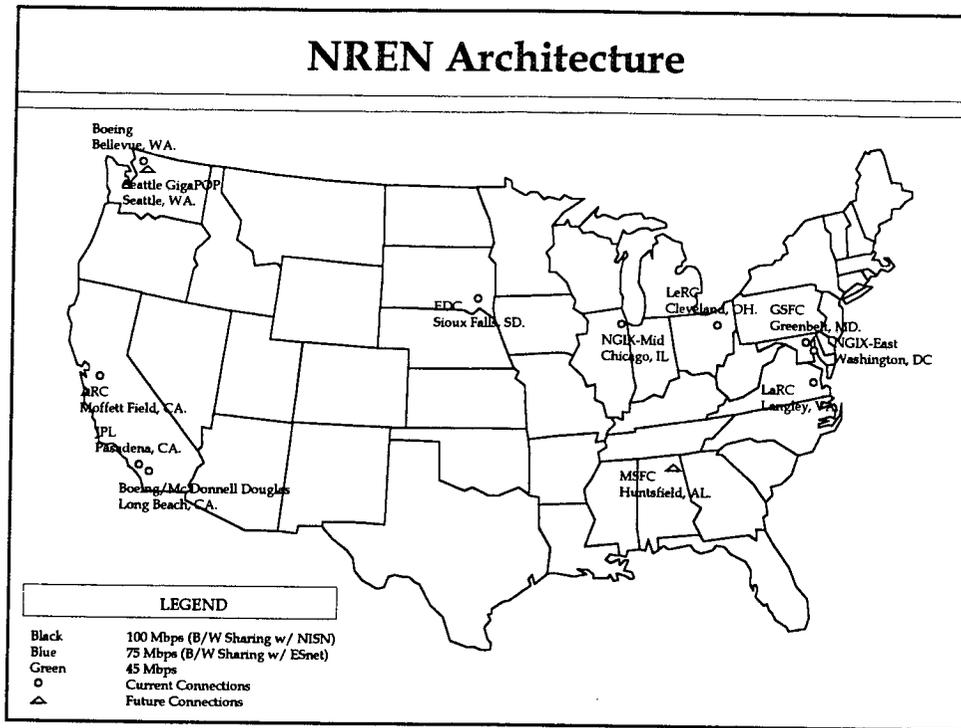


## NREN Architecture

- **ATM Based Backbone**
- Sprint ATM Service
- OC-3 & DS-3 Circuits
- **ATM & IP Routed Based Connections**
- **Interconnections to NGIX's**
- **Connections to Five NASA Research Centers**
- **Planned Connections to Operational Centers**
- **Connections to Boeing**
- Seattle
- Long Beach (MacDonnel Douglas)

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# NREN Architecture





## NREN Applications

- **Prototype revolutionary applications to support future NASA missions.**
- **Focus is on end-to-end application demonstrations in realistic network environments, pushing limits of scalability.**
- **Integrate emerging technologies into NASA/NGI Applications.**

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## NREN Applications

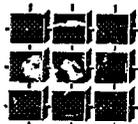
**Accelerate network technology delivery to meet unique NASA unique mission requirements today.**



Virtual Flight Simulation Laboratories



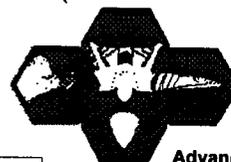
Telemedicine, Interactive Consultations, Remote Protocols and Procedures



Advanced Science Investigations for Mission to Planet Earth



Astrobiology Institute Collaboratories, Virtual Aerospace Environment



Advanced Aerospace Design and Test Tools - Wind Tunnels on-line

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## Real-Time, Interactive Echocardiography Over WANs

*Lewis Research Center & Ames Research Center*

**NCI Applications**

This demonstration represents a collaboration between the NASA Lewis Research Center, NASA Ames Research Center, NASA Johnson Space Center, and the Cardiovascular Imaging Center of the Cleveland Clinic Foundation.

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## Remote Operation: Nomad Rover in Chile

*Carnegie Mellon University, Goddard Space Flight Center and Ames Research Center*

"Dewarped" image of panospheric view

Nomad's Virtual Dashboard

Panospheric camera provided continuous 360-degree panoramas at one frame per second

Information sent to and from satellite

Atacama Desert

Chilean students with Nomad

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## Remote Interactive Virtual Simulation Laboratory

Johnson Space Flight Center & Ames Research Center

Ames Research Center

Johnson Space Center

Monitoring the Orbiter's approach and landing at ARC

Computer simulated out-the-window cockpit view

A timelapse of the Vertical Motion Simulator in action at ARC

"Teleresearcher" at JSC

Screen capture of the display

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## NREN Applied Research



QoS: investigation and potential deployment of Class Based Queuing (CBQ) and RSVP. Development of bandwidth broker

Security: Pilot and deployment of a large scale decentralized Public Key Infrastructure (PKI), Certification Authorities, integration of Kerberos and PKI

Multicast: Pilot and deployment of a large scale native multicast network

IPv6: Introduce IPv6 as an enabling technology for scaling QoS, multicast and other new services

Routing-with-Switching: Experiments in high performance core network switching and routing elements

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## **NREN Applied Research**

Congestion Control: Deploy ATM based ABR and CBR services, Weighted Random Early Drop (WRED)

Giga/Terabit Technologies: Deployment of gigabit and terabit networking strategies

Network Management: Investigate self healing networking strategies

Performance Benchmarks: Develop an Internet standard suite of performance benchmarks

NGI Exchanges: Interconnect with other NGI networks and with foreign research networks at NGI eXchanges (NGIXs)

GigaPoPs: Connect to selected gigapops for NASA applications requiring high performance connections to university sites.

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